Instruction Manual

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102

VAW METER

Serial No. 950 and above

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MODEL 102 VAW METER

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MODEL 102 VAW METER*

Electrical Specifications

Voltage Ranges: Nine: 1.5, 3, 6, 15, 30, 60, 150, 300, 600 RMS Volts.

Ampere Ranges: Fourteen: .0015, .003, .006, .015, .03, .06, .15, .3, .6, 1.5, 3, 6, 15, 30 RMS Amperes.

Watt Ratings: Following table is based on unity (1) setting of POWER FACTOR SWITCH. For 0.1 setting of this switch multiply the watt values in the table below by 0.1.

Amps.	1.5V	3.0V	6.0V	15V	30V	60V	150V	300V	600V
.0015	.00225	.0045	.009	.0225	.045	.09	.225	.45	.9
.003	.0045	.009	.018	.045	.09	.18	.45	.9	1.8
.006	.009	.018	.036	.09	.18	.36	.9	1.8	3.6
.015	.0225	.045	.09	.225	.45	.9	2.25	4.5	9.0
.030	.045	.09	.18	.45	.9	1.8	4.5	9.0	18
.060	.09	.18	.36	.9	1.8	3.6	9.0	18	36
.150	.225	.450	.90	2.25	4.5	9.0	22.5	45	90
.300	.45	.9	1.8	4.5	9.0	18	45.0	90	180
.600	.9	1.8	3.6	9.0	18.0	36	90	180	360
1.5	2.25	4.5	9.0	22.5	45	90	225	450	900
3.0	4.5	9.0	18	45	90	180	450	900	1800
6.0	9.0	18	36	90	180	360	900	1800	3600
15.0	22.5	45	90	225	450	900	2250	4500	9000
30	45.0	90.0	180	450	900	1800	4500	9000	18000

Power Factor: Two power factor ranges are provided for the watts scales: One is for unity power factor; the other for 10% (0.1) power factor. More appropriately the 10% power factor range is a provision expanding watt readings by a factor of ten. (See text.)

Frequency Range: 20 cps - 100 kc (P.F. = 1) 20 cps - 40 kc (P.F. = .1).

Overall Accuracy: ±3% (P.F. = 1, 20 cps - 40 kcps).
±10% (P.F. = 1, 40 kcps - 100 kcps).
±3% (P.F. = 0.1, 20 cps - 20 kcps).
±10% (P.F. = 0.1, 20 kcps - 40 kcps).

Volt & Ampere: In terms of the average value of the full rectified sine wave, Volt and ampere scales are calibrated in RMS values.

Watt Readings: In terms of VAcosØ. If harmonics are present, watt readings will be the sum of powers due to fundamental and harmonics of voltage and current. There is no waveform error in watts readings for frequencies within rated values.

Meter Calibration: Selectively reads RMS volts, RMS amperes or watts.

Scales: All scales are linear.

Input Impedance: Input resistance is 1 megohm for all voltage ranges. Input capacity is about 25 uufd.

*The VAW Meter is protected by United States Patents and the word "VAW" is a registered trade mark.

Electrical Specifications (Continued)

Shunt Drop:	Shunt drop is forty-five millivolts (0.045 v) at full scale current.
Overload Capacity:	At least three times, appreciably more on most ranges. Limited by shunt dissipation for current and input circuits for voltage.
Regulated Power Supply:	Line voltage variations from 105 to 125 volts at 60 cps cause less than 0.5% variation in readings. Highly regulated plate supply and regulated filament supply are utilized.
Power Requirements:	Nominal input voltage 117 volts, 60 cps, 135 watts, Line voltage range 105 to 125 volts.
Fuse Rating:	Three amperes.

Mechanical Specifications

Weight:	Twenty-seven pounds.
Dimensions:	Overall size: 15 1/2" wide, 10-1/2" high, 13-1/2" deep.
Finish:	Baked gray leather grain, smooth gray baked enamel on front panel.
Price:	$555.00 standard model; $605.00 rack mounting model; both FOB factory.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant. Prices subject to change without notice.

MODEL 102 VAW METER

INSPECTION

After unpacking the Model 102, it should be carefully inspected for damage received in transit. If damage is found a claim should immediately be made against the carrier. Shunts are packed in the same container as the Model 102. Make certain that all shunts are accounted for before disposing of the shipping container. Check the contents against the packing slip. Reference should be made to the Warranty Section of this instruction manual for the procedure to be followed if any shipping damage has occurred.

INITIAL OPERATION

Plug the power cord from the Model 102 into a suitable source of power rated at a nominal 117 volts, 60 cps. Turn the power switch to "ON" position. The pilot light should glow. If not, look for a blown fuse or open pilot light. If this does not remedy the fault, disconnect the instrument immediately, and look for internal shipment damage.

Allow the instrument to warm for at least five minutes. If the instrument has been brought in from a cold atmosphere and is thoroughly chilled, allow about fifteen minutes for this warm-up. Next set the "VAW" switch (lower right-hand knob) to "W", and adjust "ZERO W" knob to bring the meter pointer to zero. Plug in a shunt of desired rating; connect the circuit to be measured; set the "VOLTAGE RANGE SWITCH" to the desired range; and the instrument is ready for use. WHILE THE OPERATION OF THE MODEL 102 VAW METER IS THIS SIMPLE, PLEASE READ THE REST OF THIS INSTRUCTION BOOK FOR OPERATING DETAILS THAT WILL BE OF MUCH USE TO YOU IN GETTING THE MOST FROM THIS INSTRUMENT.

CONTROLS AND TERMINALS

The following controls and fittings are provided on the Model 102 VAW Meter for use in its operation.

Designation	Location	Function and Remarks
Input terminals marked "H" and "G" (Line side terminals)	Upper left front panel	"H" terminal is to be connected to high side of the POWER SOURCE. "G" terminal is grounded to Model 102 case and is to be connected to ground side of POWER SOURCE.

Designation	Location	Function and Remarks
Output terminals marked "H" and "L" (Load side terminals)	Upper left front panel	"H" terminal is to be connected to one side of LOAD. "L" terminal is to be connected to other side of LOAD. "L" is above ground by shunt drop.
Shunt jacks	Upper left front panel	Shunt plugs into these three jacks with coaxial plug at bottom.
Meter	Upper center front panel	All readings of volts (V), amperes (A) and watts (W) are read on the scales of this meter.
Zeroing knob for watts scales marked "ZERO W".	Upper right front panel	Utilized only in setting meter pointer to zero on watts scales. This "Zeroing" must be done with no signal input to VAW Meter.
Voltage range switch	Lower left front panel	Utilized in setting desired voltage range to any one of full scale values engraved on panel.
Power factor switch marked "POWER FACTOR"	Lower center front panel	Switch has two positions, ".1" and "1". In position "1", full scale watts are equal to the product of shunt rating and voltage range switch setting. For ".1" position full scale watts are equal to that determined at "1" setting multiplied by 0.1 (1/10).
Reading selector switch marked "V", "A", and "W"	Lower right front panel	Causes meter to read selectively volts, amperes, or watts when this switch is respectively in "V", "A", or "W" position.
Power switch and pilot light	Lower right front panel	Power switch turns VAW Meter on in upper position, off in lower position. Pilot light shows power on.
Fuse	Back of case	Fuse holder protrudes from rear of instrument case and is accessible without removal of any screws.

STEP-BY-STEP OPERATION

1. Connect the Model 102 to a nominal 117 volt, 60 cps line and allow at least a five minute warm-up period.

2. Connect lines to the VAW Meter from the power source and from the load. Be sure to connect the high side of the power source to one "H" post. Connect the grounded side of the generator to the "G" post. Connect one side of the load to the other "H" post; the other side of the load to the "L" post. Connections to the "H" post may be interchanged; but connections to the "G" and "L" posts must be connected as herein described, otherwise the wattmeter will read below zero.

3. Select a shunt of suitable rating, and plug it into the shunt jacks.

4. Set the voltage selector switch to the required voltage range.

5. Set the power factor switch to position "1".

6. With no voltage or current from the power source and with the VAW switch set to "W", adjust the meter needle to zero by rotation of the "ZERO W" knob. Do not adjust this knob in the presence of any input since this may not produce a true "W ZERO".

7. Cause power to flow from the generator to load. Read values of load voltage, load current, and load power, by successively rotating the "VAW" switch through "V", "A", and "W" positions.

8. If the "W" (watts) readings are less than 10% of full scale, throw the "POWER FACTOR" switch to the ".1" position. This will cause the deflection of the meter needle on watts scales to be increased by a factor of ten. Under this condition the multiplier of 0.1 must be used with indicated watts readings. Note that this feature should not be used to increase "W" readings in lieu of using a shunt which will give as near a full-scale current as possible. This will insure the best accuracy.

9. Note that with the "POWER FACTOR" switch in the "1" position, the value of the full-scale watt arc is the product of the shunt rating times the setting of the voltage range switch. For example, assume that a .006 ampere shunt is plugged in and that the voltage switch is set to 6 volts. Full scale watts are then (.006) (6) or .036. The scale, amongst other markings, is marked in 36 at full scale. The scale is thus direct reading in significant figures to which must be applied a multiplying factor of .001.

10. Note that with the "POWER FACTOR" switch set in the ".1" position the value of the full scale watts is determined in step 9 above but with an additional multiplier of 0.1 (1/10) applied to the watt readings. Using the above example, the full scale watts would be (.006) (6) (.1) or .0036.

DETAILS OF OPERATION

As in any instrument, certain precautions must be observed in the operation of Model 102. First, the "G" post is connected to the case electrically. If, for some reason, the external lead connected thereto by the user is above ground, or above the potential of surrounding objects, the case likewise will be above ground or such objects. If this difference in level is sufficient to constitute a personnel hazard, adequate precautions must be taken in operating the Model 102 to prevent accidental shock. Such operation is not recommended.

The Model 102 with its ability to act as "a very low power factor wattmeter", that is, its ability to read power in highly reactive loads, represents a very high sensitivity in power measuring equipment. Consequently, the "POWER FACTOR" switch should be kept in the unity or "1" position, except when actually needed in the 10% or ".1" position. If the watt reading is 10% or less of full scale, when the "POWER FACTOR" switch is in the unity (1) position, then it is permissible to throw this switch to the .1 position. It is always, also, well to check all three readings ("V", "A", and "W") to see that they do not exceed full scale before taking any readings. This will prevent overload errors.

NOTE THE FOLLOWING PARAGRAPHS. The Model 102 is not a compensated type of wattmeter owing to its multiplicity of ranges. (There is a maximum of 252 full scale values of watts ranges.) Without compensation, the wattmeter must inherently read either the power consumed in the potential circuit or the power consumed in the shunt. It is possible to omit one of these, but not both, as far as readings of watts are concerned in an uncompensated wattmeter. The choice is usually based on the minimum loss element or the one whose consequent error contribution will have to be least often taken into account.

In the Model 102 the shunt loss is read by the wattmeter. The input circuit for the Model 102 is as shown below along with the normally used external connections.

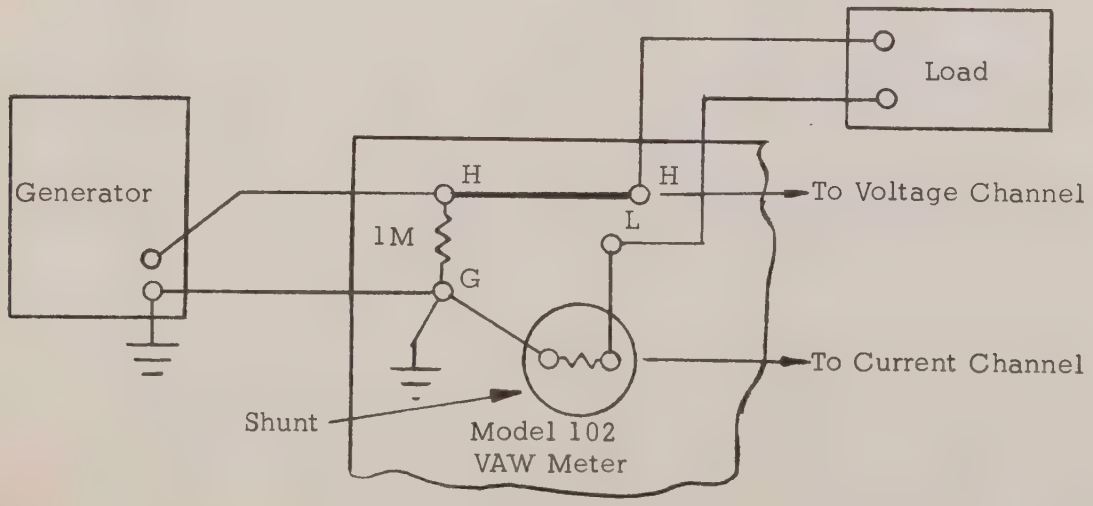


FIGURE I.

Corrections for shunt loss must be made at low voltage ranges for reading low power factor watts accurately on the Model 102. This importance is greatest at the lowest voltage ranges and disappears for the upper voltage ranges. It is of little importance on the voltage readings. The shunt drop is constant for any shunt, for a given percentage of rated current since at rated current for any shunt, the shunt drop is .045 volt (45 millivolts). The resistance of any shunt may be determined by dividing .045 volt by the shunt rated current. Thus the following values are derived:

Shunt Rating Amperes	Shunt Resistance-Ohms	Shunt Rating Amperes	Shunt Resistance Ohms
.0015	30	.3	.15
.003	15	.6	.075
.006	7.5	1.5	.03
.015	3	3.0	.015
.03	1.5	6.0	.0075
.06	.75	15.0	.003
.15	.3	30.0	.0015

Since the Model 102 reads current in amperes flowing to the load, it is obvious from Figure 1 that this current also flows through the shunt. Thus, it is always possible to calculate the effects of the shunt drop. The voltage drop of the shunt is found as follows:

$$\text{Shunt drop in volts} = \frac{(\text{"A" reading})\,(.045)}{\text{Shunt rating}} = (\text{"A" reading})\,(\text{shunt resistance})$$

The power loss in the shunt is found as follows:

$$\text{Shunt loss in watts} = I^2R = (\text{"A" reading})^2(\text{shunt resistance})$$

Thus the voltage readings can be corrected for shunt drop by subtracting this drop from the voltage "V" actually read. This will be seen to be a small error, even for the lowest scale of 1.5 volts, since at full-scale current it can be only .045 volts or 3% of full scale. At the 3 volt range it is only 1.5% of full scale, at the 6 volt range .75%, etc. The watt readings are not appreciably affected by shunt loss for the unity setting of the "POWER FACTOR" switch, but they will be very appreciably affected for the 10% setting of the "POWER FACTOR" switch, for the low voltage ranges. The shunt loss watts, as computed above, should be subtracted from the value of watts read. To illustrate, let us assume that the voltage range switch is on the 1.5 volt setting, that a .006 ampere shunt is in use, and that the" POWER FACTOR" switch is in the .1 position. Also, assume that full scale current, or .006 ampere, is indicated. The shunt resistance is 7.5 ohms. The shunt loss is (.006) (.006) (7.5) or .00027 watt. The full-scale watt value is

(.006)(1.5)(.1) or .0009 watt. Thus, the shunt loss is a very appreciable portion of the watt scale, and it must be subtracted from the watts read on the scale. In this case the shunt loss is 30% of the full-scale value. If the "POWER FACTOR" switch had been in the unity or "1" position, the shunt loss would have been only 3% of full scale watts. Or if the voltage range switch setting had been 15 volts, the shunt loss would also have been only 3% of the full scale watts. For other voltage settings, the relative values of shunt loss to full scale watts are proportional for the same current. As the current is decreased from full-scale value, whatever the shunt in use, and as the voltage range setting is increased, the shunt loss correction rapidly becomes smaller. Either a quick calculation as described herein or familiarity with the Model 102 readily will indicate whether to ignore the shunt loss or not.

Table II below has been prepared to summarize the voltage and power corrections to be applied as a function of voltage range switch setting. Note that the table is prepared for full-scale values of current and that the shunt voltage drop at full-scale current is .045 volt.

TABLE II

(1) Voltage Range Switch Setting, Volts "V"	(2) % error in voltage reading caused by shunt drop*	(3) % of full scale watt reading due to shunt loss. "Power Factor Switch" at .1**	(4) Same as (3) but for "Power Factor Switch" set at 1.0**
1.5	3%	30%	3%
3	1.5%	15%	1.5%
6	.75%	7.5%	.75%
15	.3%	3%	.3%
30	.15%	1.5%	.15%
60	.075%	.75%	.075%
150	.03%	.3%	.03%
300	.15%	.15%	.015%
600	.0075%	.075%	.0075%

* Error causes reading to be larger than correct value by percentage shown. For less than full-scale current error is to be multiplied by $\frac{\text{Actual Current}}{\text{Full-Scale Current}}$.

** Note that these percentages obtain for any voltage from zero plus to 100% of full scale deflection and they depend on Inly on "Voltage Range Switch" setting and on the current being at full scale. If the current is less than full scale, then these values are reduced by $\left(\frac{\text{Actual Current}}{\text{Full-Scale Current}}\right).2$

Sometimes it may be desirable to read the power flowing to a load, one side of which is grounded. Under this condition, the generator may be found to be either grounded or ungrounded. If the latter is the case, satisfactory operation may be realized by insulating the Model 102 case from any conducting path other than the connecting leads. This will depend on the level of operation and the effect of common capacities between the load and generator and the Model 102, these capacities arising through their respective housings and through their power supply transformers, which are commonly connected to the same power system. A way of eliminating this error is by the use of the connections shown in the following sketch, Figure 2.

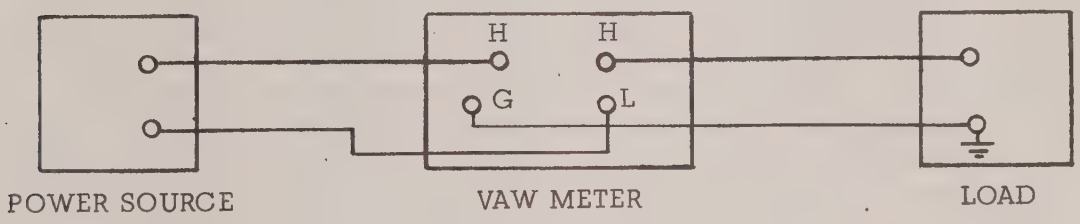


FIGURE II.

If both generator and load have one side grounded, it may be desirable to use the circuit shown in Figure 3. The transformer should have insufficient capacity between primary and secondary to short, appreciably, the shunt. The transformer has been placed on the generator side so that its losses will not be read by the wattmeter. Where the "G" and "L" posts are interchanged, it will be necessary to get into the Model 102 and reverse two connections, as noted on the circuit diagram in this manual, in order to get up-scale watt readings.

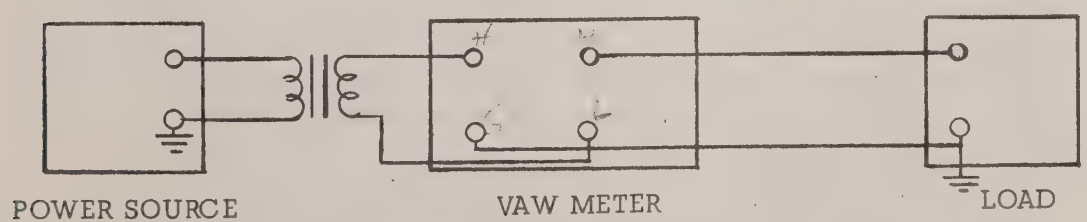


FIGURE III.

There is inherently no waveform error in the watt readings presented on the VAW Meter assuming no phase or amplitude distortion in the VAW Meter amplifiers, or other residual errors such as indicating instrument non-linearities, etc. Practically, the absence from waveform error is limited by the amplifiers. In the

Model 102 the amplifiers have a response which is flat in amplitude and they introduce no phase shift over a frequency range in excess of 20 to 20,000 cps. Hence the Model 102 will indicate accurately the power being delivered by non-sinusoidal periodic waves of voltage and current where the fundamental frequency is 20 cps or greater and where the highest harmonics of voltage and/or current of interest do not appreciably exceed 20 kc. Hence the watt readings will be the sum of the powers due to the individual harmonic quantities. That is, the "W" readings will be $W = V_n A_n \cos\phi_n$ where "n" denotes corresponding harmonic quantities. While no practical limit can be given here for the general case, it is obvious that a wave with 20 kc fundamental, and possessing appreciable percentages of much higher harmonics, error in actual total power may derive due to failure of the Model 102 amplifiers to preserve phase relations between the various harmonics and also due to modification of the amplitudes of the harmonics. For usual cases, harmonics or frequencies as high as 40 kc will be handled with only several percent increase in error. The error is greatest for the low power factor watt ranges where very small changes in phase angle may affect the readings appreciably. You should note that at full-scale values on the 10% power factor range the total scale arc represents only about 6 degrees, or the angle between current and voltage is 84 degrees. Thus the deflection of each ten percent of "W" scale, under this condition, is equal to .6 degrees or 36 minutes of arc. (These angles are approximate; see trigonometric tables for more accurate values).

The volt and ampere readings are obtained by separately rectifying signals from the voltage and current channels in full-wave manner and applying the resultant signal-proportional direct voltage to the panel meter. Using full-wave rectification gives the minimum wave-form error compared with half-wave or peak methods. While the error resulting from distorted waves is dependent on magnitude and phase of the harmonics, it is helpful to know the maximum value such errors may reach. Table II illustrates several cases of reading extremes for several percentages of harmonics. Note that the "V" and "A" channels of the Model 102 are calibrated in terms of RMS value of a sine wave. Note, also, from the circuit diagram, that a rectifying circuit is incorporated in the feedback path. This results in high order linearity of meter readings as well as improved long term accuracy of calibration.

The meter scale is provided with a scale marked "Cosϕ". This scale thus can be used to read power factor directly, or it can be used to read directly in terms of percentage of full scale when absolute values are not required. Its primary purpose is for the former use. To use this scale, set (by suitable means external to the Model 102 usually) the "V" and "A" deflections to full-scale value. Switch to "W", which will then read directly in terms of Cosϕ. The full-scale value of the reading will be 100%, if the "POWER FACTOR" switch is set to unity or "1"; and it will be 10%, if this switch is set to ".1". When "V" and/or "A" cannot be set to full scale conveniently, the Cosϕ scale reading can be multiplied by

the inverse of the product of the fraction of full scale of the "V" and "A" readings. Thus if both these readings are half scale, the full scale length of Cosϕ is reduced to one-fourth of the actual scale, and the Cosϕ readings must be multiplied by the inverse of (1/2)(1/2) or 4.

TABLE III

% Harmonic	Actual RMS Value	Model 102 "V" or "A" Reading	Peak Meter Reading
0	100	100	100
10% 2nd	100.5	100	90-110
20% 2nd	102	100-102	80-102
50% 2nd	112	100-110	75-150
10% 3rd	100.5	96-104	90-110
20% 3rd	102	94-108	82-120
50% 3rd	112	90-116	108-150

CIRCUIT DESCRIPTION

There are two main amplifier channels in the Model 102. One is for amplifying a voltage proportional to circuit voltage, the other is for amplifying a voltage proportional to circuit current. The output of each of these channels can be rectified and supplied separately to a direct current meter whereby readings of circuit voltage or circuit current are effected. The voltage channel may have its gain adjusted by predetermined steps, by the "Voltage Range Switch", to give a total of nine different full scale values which have been selected to give the best coverage of the usual voltages encountered. The current channel effectively has its gain adjusted in predetermined steps by the fourteen standard shunts available. For reading watts, the outputs of the two amplifier channels are suitably combined and applied to a multiplier, whose output is proportional to the product of these two outputs and the cosine of their relative phase displacement in degrees. The multiplier contains no thermocouples, rectifiers, tubes, or moving parts. It is sealed in a small can and liquid filled. Normally, no replacement is ever required for this unit. It should not be tampered with; such voids any guarantee on this instrument. Should it fail, it will be replaced free of charge, when the Model 102 is returned prepaid to us, if it has not been disturbed in any manner.

The voltage channel is composed of V1 and V9 (see schematic diagram). Switch S1 is the voltage range switch, which provides known attenuation of the voltage input. Re1 and Re2 rectify the amplified signal which is applied to the meter "M" through switch S2, the "VAW" switch.

The current channel is composed of tubes V4, V5, and V9 and performs in a manner similar to the voltage channel, with selection of appropriate connections being effected by the switch S2 being put in the "A" position.

For reading watts, tube V2 adds the current and voltage signals. Tubes V6 and V7 subtract these two signals. These sum and difference signals are applied to two cathode followers, respectively, which apply the sum and difference signals to the multiplier. The output of the multiplier is selected by switch S2 in position "W", to apply the output of the multiplier to the panel meter and thus read watts. The power factor ranges are selected by switch S3, which modifies the gain of the adding and subtracting tubes.

Filaments of several of the amplifier tubes are supplied a stabilized voltage by a ballast tube V10. This results in improved stability of readings against the line voltage. This also materially improves the stability of the "W" zero against this condition.

Tubes V11 through V14 act as a stabilized power supply of very low internal impedance and high regulation. These features serve to minimize effects of changing line voltage and also help to stabilize the amplifiers to provide high fidelity amplification of signals in both amplitude and phase, which is extremely essential to this instrument.

It should be noted that in several places the circuit is equipped with "trimmer" capacitors or resistors. These are usually associated with the precision - type film resistors. You are cautioned against disturbing these components during maintenance. Their being moved may result in impairing the accuracy of watt readings in the 5 kc to 20 kc region.

MAINTENANCE

Poor amplifier tubes (low filament - to - cathode insulation and tubes with radically different constants from the characteristics of the type) will cause reading errors. The former will usually evidence itself in some meter deflection in the absence of any input. The latter may affect reading accuracy in spite of the large amount of negative feedback employed. Tubes V3 and V8 must be near enough alike in characteristic to allow P5, "ZERO W" control, to zero the watt scales. Failure of any range to read on application of a signal will usually be due to a blown

fuse, failure of an amplifier tube, or failure of the rectifier tube, or regulator tubes V14 and V13, respectively. Failure of V11 or V12 will result in erratic operation and may cause oscillation of the meter pointer. When replacing any of the power supply system tubes, the output voltage of the regulator should be checked and found to be 245 volts, adjusting P8 as needed. V10 should glow only for a few seconds after turning the Model 102 on. After that, it should be dark. Its output voltage should be about 6.3 volts. Failure of V10 will make it difficult or impossible to zero "W". Also, instrument calibration will be impaired.

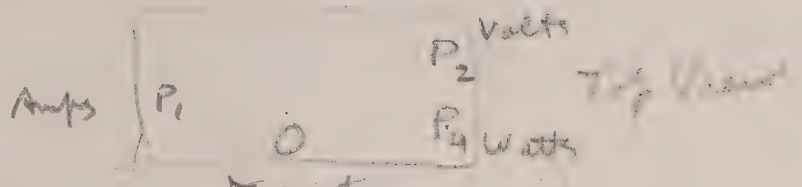
Keep the instrument clear by wiping it out when necessary. Do not restrict its natural ventilation. Do not turn things while looking for misoperation - most failures are simple things and can be found with a little patience. Take time to measure voltage, and simply observe rather than twist controls in looking for trouble. Failure to observe this will usually result in impairing the accuracy of the instrument, since the large combinations of readings found on the 102 make it somewhat difficult to recalibrate with the usual facilities to the degree of accuracy with which it was calibrated at the time of its manufacture.

In any event, the replacement of tubes or other components warrants a check of accuracy. Should the accuracy be found diminished after tube replacement, it is suggested that several tubes be tried, from which the best one may be selected for use.

TROUBLE SHOOTING CHART

TABLE IV

Symptom	Possible Cause	Remedy
(A) Instrument not operating. Pilot light not on.	(1) Blown line fuse.	(1) Replace fuse.
	(2) Open or shorted transformer.	(2) Check transformer, replace if defective.
	(3) Defective line cord or switch.	(3) Replace or repair.
(B) Instrument not operating. Pilot light on.	(1) V14, V13, V12 or V11 defective.	(1) Replace one by one.
	(2) V10 defective.	(2) Look for visible redness or open filament. Replace if red or open. This can also be checked by measuring filament voltage, e.g., pins 2 and 8 on V3 and V8 should be 6 to 6.4 volts.
(C) Watt range will not zero.	(1) V3 or V8.	(1) Replace one or both tubes selecting tubes which will allow zeroing of wattmeter with "Zero W" setting at about center of its rotation.
	(2) V10.	(2) Check V10 for open filament or for excessive drop (filament red 5 minutes or more after warmup or voltage at V3 or V4 below 6 volts on pins 2 and 8).
(D) Oscillation of meter pointer.	(1) Low or high line voltage.	(1) Measure line voltage, should be 115 to 120 volts.
	(2) Badly fluctuating line voltage.	(2) Voltage dips may go below or above d-c regulator range or fluctuations may be in excess of transient response capabilities of power supply regulator. Use more stable line voltage.
	(3) V14, V13, V12, V11.	(3) Selectively replace V14, V13, V12, or V11.
	(4) Setting of P8.	(4) Reset P8 if regulated output voltage is not between 240 and 247 volts. Reset to 245 volts. P8 is located on rear terminal board under chassis.



Symptom	Possible Cause	Remedy
(E) No voltage reading. "A" readings okay.	(1) V1. (2) Resistors on switch S1.	(1) Replace V1. (2) Check for value and replace with appropriate resistors.
(F) No current reading. "V" readings okay.	(1) V4, V5. (2) Defective shunt.	(1) Replace V4 or V5. (2) Check shunt or shunt jacks for short or poor connection.
(G) No "V" or "A" readings. "W" readings	(1) V9. (2) RE1 or RE2	(1) Replace V9. (2) Replace RE1 and RE2.
(H) No "W" reading. "V" and "A" reading	(1) V3, V8. (2) V2, V6, V7.	(1) Replace V3 and V8. (2) Replace V2, V6, or V7.
(I) "V", "A", or "W" readings out of calibration.	(1) For "V" reset P2 located at back right of chassis accessible from top. (2) For "A" reset P1 located near 6SJ7 at left front of chassis accessible from top. (3) For "W" at unity power factor reset P4 located at fight front of chassis behind Zero "W" knob accessible from top. (4) For "W" at .1 power factor reset P6 located immediately behind meter accessible from top.	

To correct calibration, proceed as follows:

(1) Use sine wave oscillator at about 1,000 cps; plug in, for example, .006 ampere shunt; set voltage range switch to 6 volts; set Power Factor Switch to 1; plug in accurate 1,000 ohm load. Set "W" to zero with no signal from oscilator. Monitor current from oscillator with thermo-ammeter (Weston Model 622, 0 - 10 ma, for example).

(2) Adjust oscillator output to give 6 ma on the thermo-ammeter. This will give 6 volts across load. Adjust P2 to make "V" read full scale.

(3) Set "VAW" switch to "A" and adjust P1 to make "A" read full scale.

(4) Set "VAW" switch to "W" and adjust P4 to make "W" read full scale.

(5) Remove thermo-ammeter and 1,000 ohm load. In its place put load of 92.5 ohms in series with about .25 mfd Mica capacitor. Set Power Factor Switch to .1. Adjust oscillator input to give full scale current as read on the "A"

scale of the Model 102. Be sure "A" reading is set right on full scale. ("V A W" switch at "A"). Now set "V A W" switch to "W" and set P6 to make "W" read full scale.

(6) Note that foregoing is an adjustment procedure adequate for most field checking. If extreme recalibration is required or extensive repairs have been made or if calibration at frequency extremes is required, it is suggested that the Model 102 be returned to the factory.

MODEL 102
LIST OF REPLACEABLE PARTS

CIRCUIT SYMBOL	DESCRIPTION	FLUKE STOCK NO.
C1A, C1B C2A, C2B C3A, C3B C4A, C4B	Capacitor, electrolytic 20/20 mfd, 450 V	CE5
C5, C6	Capacitor, electrolytic 500 mfd, 25 V	CE2
C7	Capacitor, electrolytic 2000 mfd, 6 V	CE6
C8	Capacitor, electrolytic 200 mfd, 6 V	CE30
C10, C14, C16, C22	Capacitor, paper 0.22 mfd, 400 V	CP2
C11, C13, C15, C19, C21, C23, C25	Capacitor, paper 0.1 mfd, 400 V	CP4
C12	Capacitor, electrolytic 20 mfd, 250 V	CE40
C28	Capacitor, electrolytic 16 mfd, 450 V	CE3
C17, C26, C27	Capacitor, mylar 0.22 mfd, 400 V	CP19
C18	Capacitor, electrolytic 40 mfd, 450 V	CE4
C20, C24A, C24B	Capacitor, paper 1 mfd, 400 V	CP8
C40, C41, C46, C47, C48, C49, C50	Capacitor, ceramic, variable 7-35 mmfd, 500 V	CA3
C42	Capacitor, ceramic, fixed 3 mmfd, 500 V	CT10

CIRCUIT SYMBOL	DESCRIPTION	FLUKE STOCK NO.
C43, C51	Capacitor, ceramic, fixed 39 mmfd, 500V	CT15
C44	Capacitor, ceramic, fixed 100 mmfd, 500V	CT12
C45, C52, C54	Capacitor, ceramic, fixed 82 mmfd, 500V	CT11
C53	Capacitor, ceramic, fixed 220 mmfd, 500V	CT1
C55	Capacitor, mica, variable 170-780 mmfd, 175V	CA9
R3, R6, R20, R28	Resistor, composition 22 k, 10%, 1W	GB2231
R4, R24	Resistor, composition 10 k, 10%, 1W	GB1031
R5	Resistor, composition 10 m, 10%, 1/2W	EB1061
R7, R19, R23, R27	Resistor, composition 220 k, 10%, 1/2W	EB2241
R8, R18, R21, R29	Resistor, composition 100 k, 10%, 1W	GB1041
R10, R17, R43	Resistor, composition 33 k, 10%, 1W	GB3331
R11, R31, R37, R44, R48, R49	Resistor, composition 407 k, 10%, 1/2W	EB4741
R12, R32	Resistor, composition 150 k, 10%, 1/2W	EB1541
R13, R33	Resistor, composition 18 k, 10%, 1/2W	EB1831
R14	Resistor, composition 1.5 m, 10%, 1/2W	EB1551

CIRCUIT SYMBOL	DESCRIPTION	FLUKE STOCK NO.
R15	Resistor, deposited carbon 75Ω, 1%, 1/2 w	DR23
R25	Resistor, composition 100 k, 10%, 1 w	GB1041
R34, R35	Resistor, composition 18 k, 10%, 1 w	GB1831
R36	Resistor, deposited carbon 3.89 k, 1%, 1/2 w	DR414
R30	Resistor, composition 27 k, 10%, 1 w	GB2731
R38, R39	Resistor, composition 560Ω, 10%, 1/2 w	EB5611
R40	Resistor, composition 1.5 k, 10%, 1 w	GB1521
R41	Resistor, composition 15Ω, 10%, 1 w	GB1501
R42	Resistor, composition 82 k, 10%, 1 w	GB8231
R45	Resistor, composition 12 k, 10%, 2 w	HB1231
R46	Resistor, composition 330 k, 10%, 1 w	GB3341
R47	Resistor, composition 270 k, 10%, 1 w	GB2741
R50	Resistor, wirewound 18 k, 10%, 5 w	R17K
R51	Resistor, composition 4.7 k, 10%, 1 w	GB4721
R54, R55	Resistor, composition 5.6 k, 10%, 1/2 w	EB5621

CIRCUIT SYMBOL	DESCRIPTION	FLUKE STOCK NO.
R56	Resistor, wirewound 150Ω, 5%, 10 w	R150WA
R100	Resistor, deposited carbon 900 k, 1%, 1/2 w	DR622
R101	Resistor, deposited carbon 90 k, 1%, 1/2 w	DR512
R22, R102	Resistor, deposited carbon 10 k, 1%, 1/2 w	DR51
R103	Resistor, deposited carbon 1.5 k, 1%, 1/2 w	DR44
R104	Resistor, deposited carbon 5.44 k, 1%, 1/2 w	DR410
R105	Resistor, deposited carbon 1.845 k, 1%, 1/2 w	DR45
R106	Resistor, deposited carbon 135Ω, 1%, 1/2 w	DR31
R107, R108, R115, R116, R118	Resistor, deposited carbon 50 k, 1%, 1/2 w	DR59
R109, R114	Resistor, deposited carbon 40 k, 1%, 1/2 w	DR57
R110, R113	Resistor, deposited carbon 135 k, 1%, 1/2 w	DR65
R111, R112	Resistor, deposited carbon 200Ω, 1%, 1/2 w	DR32
R117	Resistor, deposited carbon 52.14 k, 1%, 1/2 w	DR510
P1, P2	Potentiometer, wirewound 1 k, 10%, 2 w	P1KA
P3	Potentiometer, wirewound 2 k, 10%, 2 w	P2KA

CIRCUIT SYMBOL	DESCRIPTION	FLUKE STOCK NO.
P4, P6	Potentiometer, wirewound 300Ω, 10%, 2 w	P300A
P5, P8	Potentiometer, wirewound 5 k, 10%, 2 w	P5000A
P9	Potentiometer, wirewound 500Ω, 10%, 1/4 w	P500TB
V1, V9	Tube, dual triode Type 6SN7	6SN7
V2, V5, V6, V7	Tube, pentode Type 6AC7	6AC7
V3, V8	Tube, power pentode Type 6V6	6V6
V4	Tube, pentode Type 6SJ7	6SJ7
V10	Tube, current regulator Type 22-4	22-4
V11	Tube, voltage regulator Type OD3	OD3
V12	Tube, dual triode Type 6SL7	6SL7
V13	Tube, power dual triode Type 6080	6080
V14	Tube, rectifier Type 5Y3	5Y3
RE1, RE2	Diode, germanium Type 1N51	X42
M1	Meter, 500 u amp. dc with special scale	M2
S-CAN	Wattmeter squaring element special	X260

CIRCUIT SYMBOL	DESCRIPTION	FLUKE STOCK NO.
L1	Reactor, filter, 7 h, 140 ma	TC2
T1	Transformer, power	102-611
S1	Switch, rotary 4 pole, 9 pos., 4 deck	SR1
S2	Switch, rotary 3 pole, 3 pos., 1 deck	SR4
S3	Switch, rotary 3 pole, 2 pos., 1 deck	SR4
S4	Switch, toggle, SPST 115/230 v, 3 amp.	ST5
F1	Fuse, 3 ampere	F3
L1	Pilot lamp, 6-8 v, Type 44	X34
	Fuse holder	X12
	Pilot Light	X14
	Input jack	X31
	Knob, 2 inch, pointer	X232
	Knob, 1-1/2 inch, pointer	X234
	Cable, power 3 conductors #18	X27H
	Bushing, strain relief	X212
	Foot, rubber mounting	X224
	Handle, case carrying	X2062

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

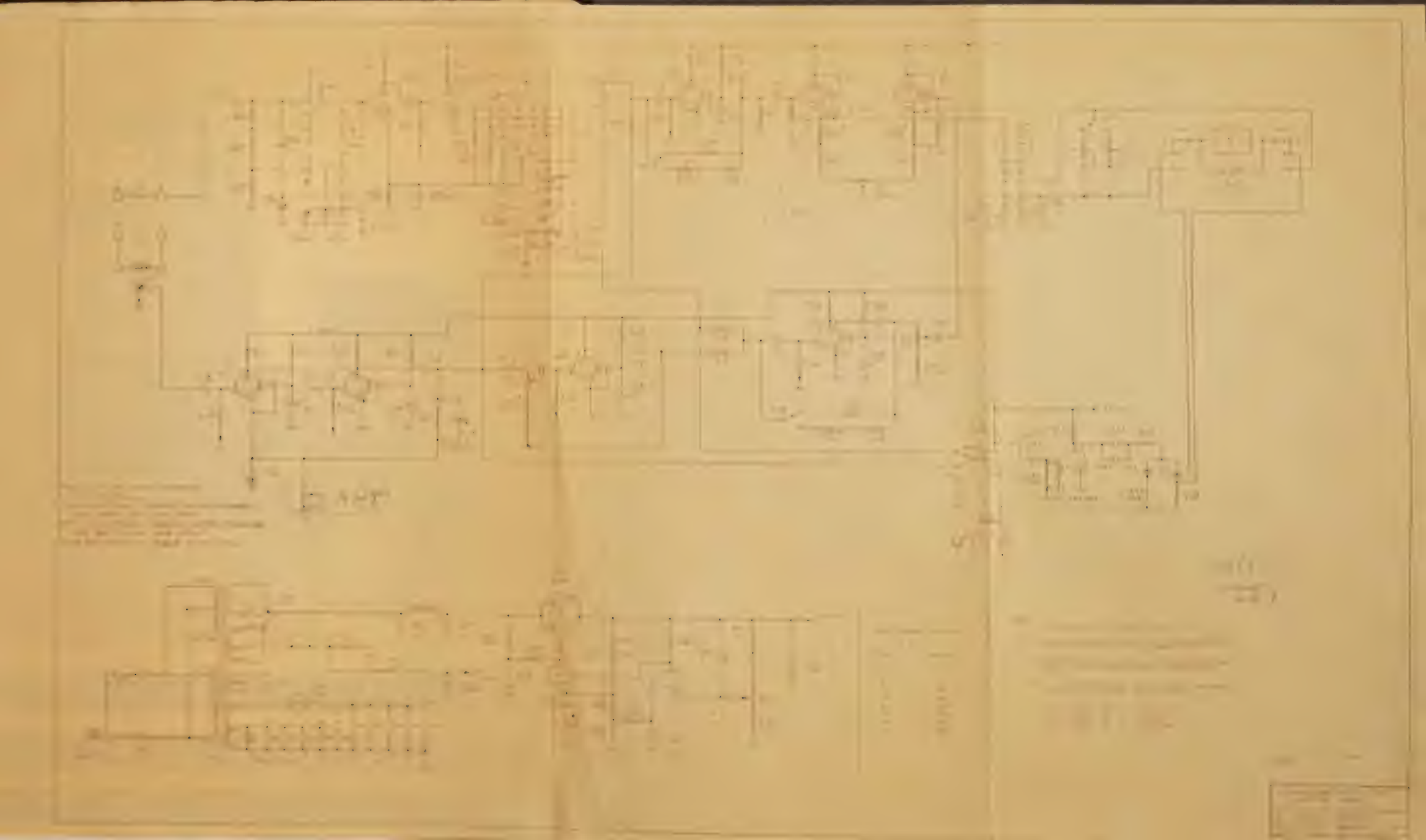
The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON

B+ 250 ± .75V.

105 −125V.

5/3



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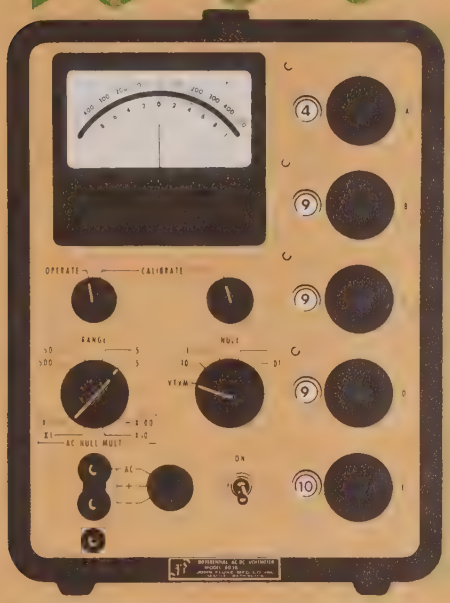
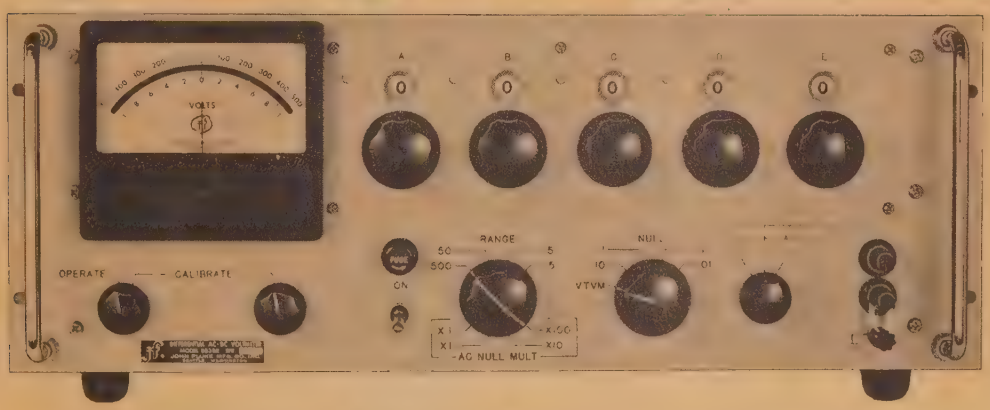




JOHN FLUKE MFG. CO., INC.

PRECISION INSTRUMENTS

CATALOG DIGEST 3-63

DIFFERENTIAL VOLTMETERS • MILITARIZED DIFFERENTIAL VOLTMETER • TRUE RMS VOLTMETER

POWER SUPPLIES • CALIBRATORS • THERMAL TRANSFER STANDARDS • THERMAL CONVERTERS

UNIVERSAL IMPEDANCE BRIDGE • VAW METER • PRECISION VOLTAGE DIVIDERS • ACCESSORIES

FLUKE DIFFERENTIAL VOLTMETERS

Accuracy • Reliability • Ruggedness • Versatility

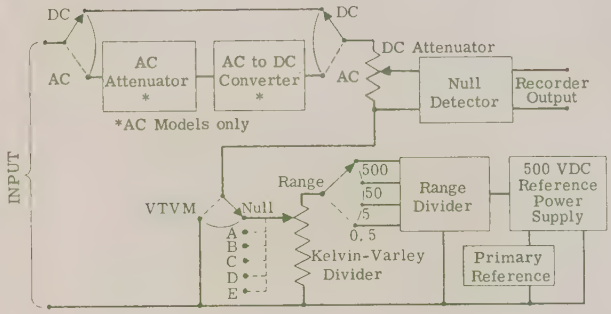
a great combination . . .

provided by each instrument in the Fluke line of differential voltmeters—advantages unequaled in any other type of voltage measuring instrument available in today's market.

In addition, when extreme DC measurement accuracy is required, there is complete freedom from source loading error provided by infinite input impedance, another feature common to all Fluke Differential Voltmeters. The table below illustrates the importance of this feature.

SOURCE LOADING ERROR

Source Resistance	Voltmeter With 10 Megohm Input Resistance	Fluke Voltmeter At Null
1 K	0.01%	0
5 K	0.05%	0
10 K	0.1%	0
50 K	0.5%	0
100 K	1%	0
500 K	4.8%	0
1 M	9.1%	0



Examination of the simplified block diagram reveals that the Fluke DC Differential Voltmeter is composed of four basic sections:

(1) A primary reference, either standard cell or zener diode, used to calibrate . . .

(2) the 500V precision reference supply, which is applied across . . .

(3) the Kelvin-Varley voltage divider, the output of which is adjusted by the voltage dials to equal the unknown being measured. Equality between the Kelvin-Varley output and the unknown voltage is determined by . . .

(4) the null detector, a chopper-stabilized DC amplifier.

The following are a few examples of the many advantages of infinite input impedance:

(1) Critical tube and transistor potentials are unaffected by measurement.

(2) Long leads to the voltage source have no effect on accuracy (such as remote thermocouple measurements).

(3) Measurements in the DC feedback loop of amplifiers and servos have no effect on over-all gain.

(4) Absolute measurements may be made where source resistance is unknown or difficult to determine.

(5) Stored potentials and electrostatic sources may be measured without reducing the source voltage.

(6) Voltage ratios of divider networks remain constant when a measurement is made across a portion of the divider.

AC/DC versions of the Fluke Differential Voltmeters (Models 803B, 803D, and 823A) provide the capability of highly accurate, wide frequency range AC measurements in addition to the DC capabilities described above. This is accomplished by means of an AC to DC converter placed ahead of the DC portion of the instrument. The heart of this converter is an extremely stable, low noise amplifier, with virtually flat frequency response over the specified frequency range.

AC/DC

MODEL 803B

INPUT VOLTAGE RANGE:
0 to 500V AC and DC

ACCURACY (% OF INPUT):
DC: ± 0.05% from 0.1 to 500V DC
± (0.05% +50 uv) below 0.1V DC

AC: (20 cps to 10 KC)
± 0.2% from 0.5 to 500V AC
± (0.2% +25 uv) from 0.001 to 0.5V AC
(10 cps to 20 cps)
± (0.5% +25 uv) from 0.001 to 500V AC
(5 cps to 10 cps)
± (3% +25 uv) from 0.001 to 500V AC

NULL RANGES:
± 10, ± 1, ± 0.1, ± 0.01V AC and DC;
± 100, ± 0.001V AC

INPUT IMPEDANCE:
DC: Infinite at null from 0 to 500V DC
AC: 1 Megohm, 35 uuf (500 and 50V AC ranges)
1 Megohm, 50 uuf (5 and 0.5V AC ranges)

MAXIMUM METER RESOLUTION:
50 uv DC; 5 uv AC

REFERENCE:
Standard Cell (Zener diode optional)

DIMENSIONS:
Cabinet Model—9¾" wide x 13" high x 16" deep
Rack Model—19" wide x 7" high x 15½" deep

WEIGHT:
Cabinet Model—27½ pounds
Rack Model—25 pounds

PRICE:
Cabinet Model—$875.00
Rack Model—$895.00

DC

MODEL 801B

INPUT VOLTAGE RANGE:
0 to 500V

ACCURACY (% OF INPUT):
DC: ± 0.05% from 0.1 to 500V
± (0.05% +50 uv) below 0.01V

NULL RANGES:
± 10, ± 1, ± 0.1, ± 0.01V

INPUT IMPEDANCE:
Infinite at null from 0 to 500V

MAXIMUM METER RESOLUTION:
50 microvolts

REFERENCE:
Standard Cell (Zener diode optional)

DIMENSIONS:
Cabinet Model—9¾" wide x 13" high x 14" deep
Rack Model—19" wide x 7" high x 14" deep

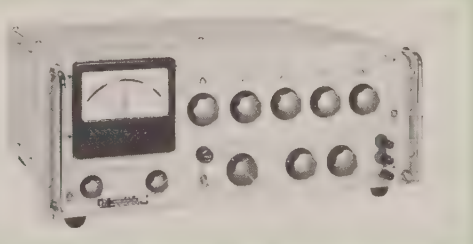
WEIGHT:
Cabinet Model—24 pounds
Rack Model—21½ pounds

PRICE:
Cabinet Model—$485.00
Rack Model—$505.00

FEATURES COMMON TO ALL FLUKE DIFFERENTIAL VOLTMETERS (except Model 8011A)

Infinite input resistance at null from 0 to 500V DC • In-line readout with automatic lighted decimal • Front panel DC polarity switch • No zero controls • Recorder output • • Taut band suspension meter • Flow soldered glass epoxy printed circuit boards • Meets shock and vibration requirements of MIL-T-945A.

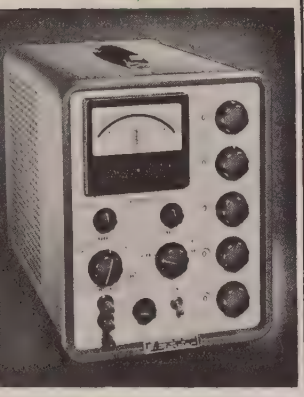
Fluke Model A-70 strip chart recorder is recommended for use with all Fluke differential voltmeters in any application where a permanent record is desired.



MODEL 803BR

All Fluke differential voltmeters are available in either cabinet models, or rack mounting models. Panel dimensions for rack models—7" x 19". Depth behind panel: DC models—14"; AC/DC models 15½".

AC/DC



MODEL 803D

INPUT VOLTAGE RANGE:
0 to 500V AC and DC

ACCURACY (% OF INPUT):
DC: ±0.02% from 0.1 to 500V
± (0.02% +25 uv) below 0.1V

AC: (30 cps to 5 KC)
±0.1% from 0.5V to 500V AC
± (0.1% +25 uv) from 0.001 to 0.5V AC
(20 cps to 10 KC)
+0.15 from 0.5V to 500V AC
± (0.15% +25 uv) from 0.001 to 0.5V AC
Reduced accuracy at extended frequencies from 5 cps to 100KC.

NULL RANGES:
± 10, ± 1, ± 0.1, ± 0.01, ± 0.001V AC and DC
± 100V AC

INPUT IMPEDANCE:
DC: Infinite at null from 0 to 500V DC
AC: 1 megohm, 35 uuf (500 and 50V AC ranges)
1 megohm, 50 uuf (5 and 0.5V AC ranges)

MAXIMUM METER RESOLUTION:
5 microvolts AC and DC

REFERENCE:
Standard Cell (Zener diode optional)

DIMENSIONS:
Cabinet Model—9½" wide x 13" high, x 16" deep
Rack Model—19" wide x 7" high x 15½" deep

WEIGHT:
Cabinet Model—28 pounds
Rack Model—26 pounds

PRICE:
Cabinet Model—$1,100.00
Rack Model—$1,120.00

DC

MODEL 825A

INPUT VOLTAGE RANGE:
0 to 500V

ACCURACY (% OF INPUT):
±0.02% from 0.1 to 500V
± (0.02% +25 uv) below 0.1V

NULL RANGES:
± 10, ± 1, ± 0.1, ± 0.01, ± 0.001V

INPUT IMPEDANCE:
Infinite at null from 0 to 500V

MAXIMUM METER RESOLUTION:
5 microvolts

REFERENCE:
Standard cell (zener diode optional)

DIMENSIONS:
Cabinet Model—9¾" wide x 13" high x 14" deep
Rack Model—19" wide x 7" high x 14" deep

WEIGHT:
Cabinet Model—25 pounds
Rack Model—22 pounds

PRICE:
Cabinet Model—$590.00
Rack Model—$610.00

AC/DC

MODEL 823A

INPUT VOLTAGE RANGE:
0 to 500V AC and DC

ACCURACY (% OF INPUT):
DC: ±0.01% from 0.5 to 500V DC
± (0.01%+10 uv) below 0.5V DC
AC: (30 cps to 5 KC)
±0.1% from 0.5V to 500V AC
± (0.1%+25 uv) from 0.001V to 0.5V AC
20 cps to 10 KC
±0.15% from 0.5V to 500V AC
± (0.15%+25 uv) from 0.001V to 0.5V AC
Reduced accuracy at extended frequencies from 5 cps to 100 KC.

NULL RANGES:
± 10, ± 1, ± 0.1, ± 0.01, ± 0.001V AC and DC
± 100V AC

INPUT IMPEDANCE:
DC: Infinite at null from 0 to 500V DC
AC: 1 megohm, 35 uuf (500 and 50V AC ranges)
1 megohm, 50 uuf (5 and 0.5V AC ranges)

MAXIMUM METER RESOLUTION:
5 microvolts AC and DC

REFERENCE:
Standard Cell

DIMENSIONS:
Cabinet Model—13" high x 9¾" wide x 16" deep
Rack Model—7" high x 19" wide x 15½" deep

WEIGHT:
Cabinet Model—Approximately 28 pounds
Rack Model—Approximately 26 pounds

PRICE:
Cabinet Model—$1,300.00
Rack Model—$1,320.00

DC

MODEL 821A

INPUT VOLTAGE RANGE:
0 to 500V

ACCURACY (% OF INPUT):
±0.01% from 0.5 to 500V
± (0.01% +10 uv) below 0.5V

NULL RANGES:
± 10, ± 1, ± 0.1, ± 0.01, ± 0.001V

INPUT IMPEDANCE:
Infinite at null from 0 to 500V

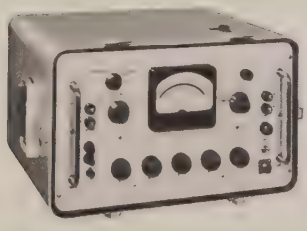
MAXIMUM METER RESOLUTION:
5 microvolts

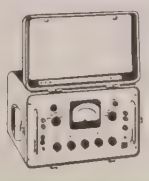
REFERENCE:
Standard cell

DIMENSIONS:
Cabinet Model—9¾" wide x 13" high x 14" deep
Rack Model—19" wide x 7" high x 14" deep

WEIGHT:
Cabinet Model—25 pounds
Rack Model—22 pounds

PRICE:
Cabinet Model—$795.00
Rack Model—$815.00





MODEL 8011A

MILITARIZED-DC DIFF. VOLTMETER

Meets all environmental requirements of MIL-T-945A

The Model 8011A is a potentiometer built to provide accurate voltage measurements under adverse environmental conditions. Housed in a light grey enameled combination case, it is portable, and virtually impossible to damage by overload. Chopper stabilized null detector, precision Kelvin-Varley resistors (hermetically sealed in oil), temperature controlled Zener reference, and drift free 500 volt reference supply, all contribute to the outstanding performance of this instrument.

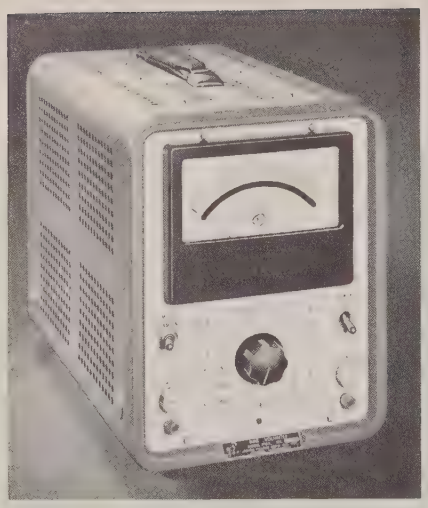
SPECIFICATIONS

INPUT VOLTAGE RANGE: 0 to 500V
ACCURACY: ±0.05% of input from 0.1 to 500V
±0.1% of input or 50 uv, whichever is greater, below 0.1V
NULL RANGES: ±10, ±1, ±0.1, ±0.01V
INPUT IMPEDANCE: Infinite at null from 0 to 500V
MAXIMUM METER RESOLUTION: 50 uv
REFERENCE: Temperature controlled Zener diode
DIMENSIONS: Combination case with cover
19" wide x 11½" high x 19½" long
WEIGHT: 57 pounds **PRICE:** $1745

DESIGNED FOR:

Continuous operation..... from —54°C to +65°C with 95% relative humidity up to an altitude of 10,000 feet

Extended storage..... from —65°C to 85°C with 100% relative humidity up to an altitude of 50,000 feet



MODEL 910A

FLUKE

TRUE RMS VOLTMETER

The Model 910A true RMS Voltmeter combines true RMS response with 1.0% accuracy over a broad frequency range. Its true RMS response, by definition, guarantees that the accuracy of the indicated reading is maintained regardless of its waveform characteristics.

SPECIFICATIONS

Voltage Range: 100 uv to 300V in twelve ranges

Decibel Range: —72 to +52 dbm in twelve ranges

Frequency Response: 10 CPS to 7 MC

Accuracy: ±1% of full scale 50 cps to 800 KC
±2% of full scale 20 cps to 2 MC
±3% of full scale 20 cps to 3.5 MC
±5% of full scale 10 cps to 7.0 MC

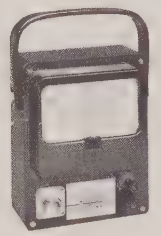
Crest Factor: Three at full scale. Nine at range switchover point.

Input Impedance: 10 megohms shunted by 30 uuf on ranges from 0.001V to 0.30V
10 megohms shunted by 15 uuf on ranges from 1.0 to 300V

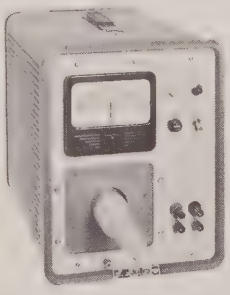
Amplifier: Output terminals provide approximately 100 mv RMS at full scale regardless of range

Dimensions: Cabinet Model—7¼" wide x 10½" high x 15" deep
Rack Model—19" wide x 5¼" high x 13¼" deep

Price: Cabinet Model—$525.00
Rack Model—545.00



MODEL 80A

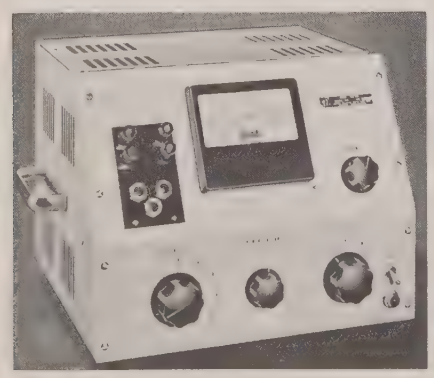


MODEL 80C

PRECISION VOLTAGE DIVIDERS

Designed for use with the Fluke Model 800 Series Differential Voltmeters, Fluke precision voltage dividers provide high accuracy measurements to 30,000V DC. All units have zero center panel meters to indicate polarity and approximate magnitude of unknown high voltage. All models draw 1 ma current at maximum input.

Model No.	Maximum Input Voltage	Total Resistance	Division Ratio 500 V Out	Division Ratio 1 V Out	Division Ratio Accuracy	Price
80A-1	1 KV	1M	2:1	—	±0.01%	$ 100.00
80A-2	2 KV	2M	4:1	—	±0.01%	110.00
80B-5	5 KV	5M	10:1	5,000:1	±0.01%	225.00
80C-10	10 KV	10M	20:1	10,000:1	±0.01%	350.00
80C-15	15 KV	15M	30:1	15,000:1	±0.01%	720.00
80C-20	20 KV	20M	40:1	20,000:1	±0.01%	845.00
80C-25	25 KV	25M	50:1	25,000:1	±0.01%	970.00
80C-30	30 KV	30M	60:1	30,000:1	±0.01%	1,095.00



MODEL 102

VAW METER

The Fluke Model 102 Vaw Meter measures voltage, current, and power over a wide frequency range. The Model 102 has a maximum true power sensitivity of 225 microwatts and will measure up to 18 kilowatts over the frequency range of 20 cps to 100 kc. With a one megohm input resistance and a shunt drop of only 45 millivolts full scale, the Model 102 generally produces negligible insertion loss effects on the circuit under test. This instrument is designed to measure true power consumed by a wide variety of loads including both linear and non linear elements such as servo components, transformers, rectifiers, and substantially any power-consuming circuit configuration.

BRIEF SPECIFICATIONS

Voltage full scale: 1.5-600V

Current full scale: 1.5 ma-30 amps

Power: 225 uw to 18 kw

Cabinet Model: $660.00

Rack Model: $680.00

POWER FACTOR RANGE	FREQUENCY RESPONSE	ACCURACY	INPUT IMPEDANCE
1.0	20 cps-40 KC	3%	1 megohm 25 uufd
1.0	40 KC-100 KC	10%	
0.1	20 cps-20 KC	3%	
0.1	20 KC-40 KC	10%	

FLUKE

THERMAL TRANSFER STANDARDS

Model 540A Thermal Transfer Standard provides extreme accuracy over a frequency range of 5 cps-500 KC. A prime advantage offered by Model 540A is that the AC and DC voltages on any range are always applied to the same portion of the transfer circuitry on a 1:1 basis thereby eliminating any error which might occur if the AC voltage were first divided down to a lower level before comparison to the DC standard voltage.

Certified by N.B.S.

MODEL 540A

FEATURES

0.02% AC/DC Transfer Accuracy • Frequency Range 5 cps—500 KC • Voltage Range 0.33 to 1000V • Search Meter for Visual Indication of Overload • High-resolution Galvanometer • Excellent Thermal Drift Characteristics • Built-in Provisions for use with:

Model A55 High Frequency Thermal Converters

Model A40 Current Shunts for AC Current Measurements

External Galvanometer

SPECIFICATIONS

VOLTAGE RANGES: 0.5, 1, 2, 3, 5, 10, 20, 30, 50, 100, 200, 300, 500, 1000 volts.

ACCURACY:

RANGES	FREQUENCY	AC/DC DIFFERENCE
0.5V	5 cps - 100 KC	±0.02%
	100 KC - 500 KC	±0.05%
1V-10V	5 cps - 500 KC	±0.02%
20V-50V	5 cps - 100 KC	±0.02%
	100 KC - 500 KC	±0.2%
100V-300V	5 cps - 50 KC	±0.03%
500V	5 cps - 50 KC	±0.05%
1000V	5 cps - 20 KC	±0.05%

CALIBRATION: Traceable to NBS standards over entire range.

Available at extra cost—
NBS Certificate to 50 KC (20 KC on 1000V range) with correction figures given to ±0.01%.
• Fluke or NBS certified test report over entire range.

TRANSFER INPUT IMPEDANCE: 200 ohms per volt.

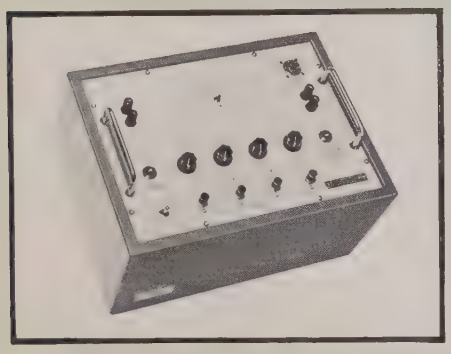
GALVANOMETER: Built-in reflecting type Binding posts and switch provided for external galvanometer.

GALVANOMETER RESOLUTION: 0.02% per millimeter at nominal range voltage.

SEARCH METER: This circuit is provided to select the proper voltage range thereby minimizing the possibility of thermocouple overload.

DIMENSIONS: 10¾" wide x 8½" high x 14½" long.

WEIGHT: 11½ pounds. **PRICE:** $795.00



Model 550A incorporates a four-dial Lindeck potentiometer, DC reference supply, polarity reversing switch, terminals for external galvanometer, and is specifically designed to complement the extreme accuracy of Model A55 converters. Included with each Model 550A is a shielded galvanometer cable and a Model 550A/A55 interconnection cable.

MODEL 550A

SPECIFICATIONS

REFERENCE VOLTAGE RANGE: 1.1 to 15 millivolts. (NOTE: Output voltage range of Fluke Model A55 Thermal Converters is approximately 1.8 to 7 millivolts from ½ to 1 times rated voltage.)

GALVANOMETER RESOLUTION: Between 0.001% and 0.006% mm on high sensitivity transfer range when used with Model A55 Thermal Converters and commercially available high-resolution galvanometers of the lightbeam reflecting type.

DC OUTPUT CONNECTOR: GR Type 874.

GALVANOMETER AND THERMAL CONVERTER INPUT CONNECTOR: Amphenol 80-PC2M two-pin microphone type.

SIZE: 15" long x 10¾" wide x 9⅜" high (including cover).

WEIGHT: 14½ pounds (including cable and cover).

PRICE: $295.00.

THERMAL CONVERTERS

Model A55 Thermal Converters make possible extremely accurate thermal transfer AC measurements from sub-audio frequencies to the VHF range. Great care has been taken in the electrical design and packaging to ensure continued accuracy comparable to NBS standards even under adverse conditions of temperature, humidity, and vibration.

SPECIFICATIONS

RANGE: 0.5, 1, 2, 3, 5, 10, 20, 30, and 50 volts. (NOTE: Each converter may be used from ½ to 1 times voltage rating.)

AC/DC DIFFERENCE

CONVERTER	1 MC	10 MC	30 MC	50 MC
0.5V	±0.01%	+0.10%	+0.50%	+1.50%
1V-10V	±0.01%	±0.03%	±0.10%	±0.10%
20V-50V	±0.01%	±0.05%	±0.10%	—

CALIBRATION: Certified to be within the above deviations from zero error as defined by NBS without calibration curves or correction tables. The 0.5V model is supplied with a test report indicating deviations to the nearest 0.01% at the above frequencies. For any converter, John Fluke or NBS certified test reports are available at extra cost.

INPUT IMPEDANCE: Approximately 200 ohms/volt.

OUTPUT VOLTAGE: 7 millivolts nominal at rated input.

OUTPUT RESISTANCE: 8 ohms nominal.

INPUT CONNECTOR: GR type 874-L.

OUTPUT CONNECTOR: Amphenol 80-PC2M 2-pin microphone type.

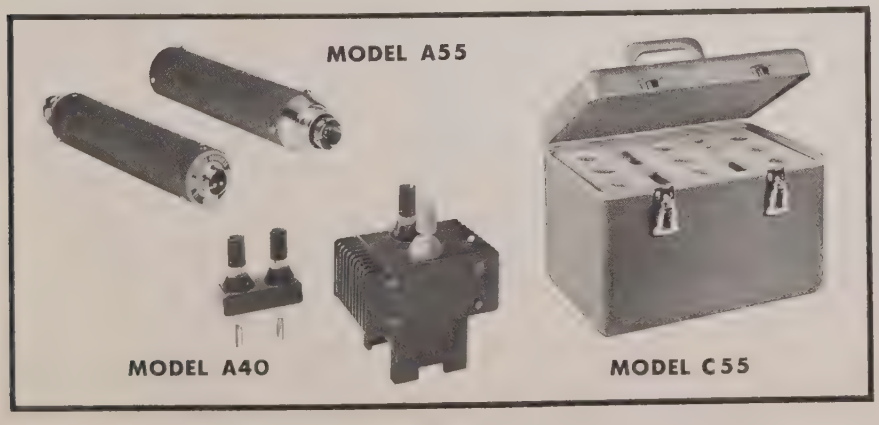
SIZE AND WEIGHT

CONVERTER	DIAMETER	LENGTH	WEIGHT
0.5V	1-3/8"	3-5/16"	10 oz.
1V, 2V	1-3/8"	5-3/16"	13 oz.
3V, 5V	1-3/8"	6-1/2"	15 oz.
10V, 20V 30V, 50V	1-3/8"	7-1/16"	1 lb.

PRICE:

0.5V $100.00
1V, 2V, 3V, or 5V. $125.00
10V, 20V, 30V, or 50V. $150.00

Model C55 storage case, $95.00 (furnished at no charge with orders for complete set of nine converters).



Model A55-110 Accessory Kit is recommended for use with Model A55 thermal converters in virtually any typical calibration or measurement setup.

Model A55-110 Accessory Kit includes:

Coaxial Tee for A55 Thermal Converter Input (GR Type 874-TL).

Three Coaxial Adapters for A55 Thermal Converter Input (GR874 to UHF jack, GR874 to BNC jack, GR874 to Type N jack).

Interconnecting Coaxial Cable, AC Source to Coaxial Tee. **KIT PRICE: $75.00.**

Model A40 AC current shunts in 13 ranges covering 10 ma-10 A for use with Model 540A Thermal Transfer Standard to cover the frequency range from 5 cps to 20 KC with accuracies comparable to Model 540A Transfer Standard. Contact your nearest Fluke representative for complete data.

FLUKE DC POWER SUPPLIES

The DC power supply is the most commonly used instrument for a great variety of applications ranging from research and development through production line testing and is often an essential system component. It is particularly important that each power supply considered should provide the utmost in flexibility of use and reliable performance at minimum cost.

Fluke DC power supplies incorporate unique design features which assure accuracy, resolution, stability, and regulation against line or load changes. No premium in cost is added by these features which are passed along as added user benefits.

PRECISION CALIBRATORS

Suggested Applications: Circuit development, reference source for production checkout system, direct meter calibration, calibration of telemetry system, analog computer system reference DC source for AC/DC transfer measurement, precision source for research work, general purpose laboratory applications.

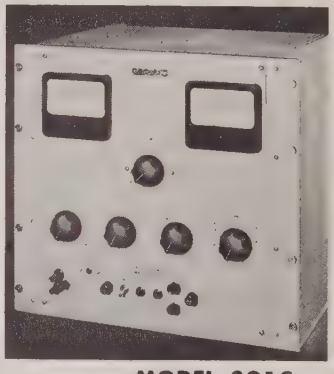
MODEL	VOLTAGE	CURRENT	REGULATION		STABILITY			CALI-BRATION ACCURACY	MAX. RIPPLE RMS	RESOLU-TION	PRICE
			LINE	LOAD	PER HOUR	PER DAY	PER MO.				
313A	0-50 v	0-2A	0.0005%	0.0005%	0.002%	0.0025%	0.005%	0.01%	100 uv	10 uv	$1,295.00
301E	1.02-512 v	0-300 ma	0.005%	0.01%	0.005%	0.01%	0.01%	0.1%	2 mv	500 uv	695.00
301C	1.02-1012 v	0-400 ma	0.005%	0.01%	0.005%	0.01%	0.01%	0.1%	2 mv	500 uv	985.00
334B	0-3111 v	0-400 ma	0.002%	0.005%	0.005%	0.01%	0.01%	0.03%	1 mv	50 uv	2,650.00

NEW
MODEL 313A

ALL SOLID STATE

313A FEATURES —
Stability 0.005% per month
Calibration Accuracy 0.01%
Line or Load Regulation 0.0005%
Ripple Less Than 100 uv
Maximum Resolution 10 uv
Remote Programming and Load Sensing
Continuously Variable Current Limiting

MODEL 301E

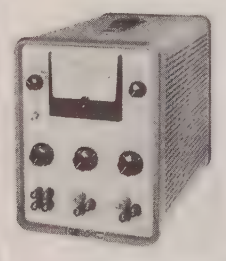


MODEL 301C

301C AND 301E FEATURES
0.1% Calibration Accuracy
Chopper Stabilization
High Current Output
0.005% Line Regulation
Standard Cell Reference
500 uv Resolution

MODEL 334B

334B FEATURES
0.03% Calibration Accuracy
50 uv Resolution over Entire
0-3111 V Range.
Chopper Stabilization



GENERAL PURPOSE LABORATORY POWER SUPPLY

MODEL 407D

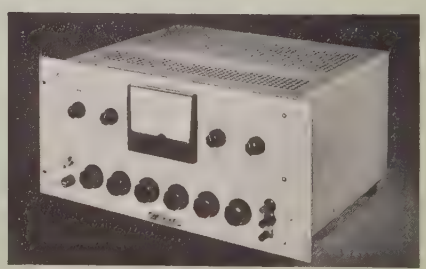
407D FEATURES
0.01% short term stability—2 mv resolution — Precision fixed and variable wirewound resistors—Dual bias and filament outputs—Tight line and load regulation—Low ripple.

**Model 407D also available as rack mounted model 407DR
19" wide x 8¾" high x 16½" deep
Weight—48 lbs. Price—$355.00

MODEL	VOLTAGE	CURRENT	REGULATION		STABILITY		CALI-BRATION ACCURACY	MAX. RIPPLE RMS	RESOLUTION	PRICE
			LINE	LOAD	PER HOUR	PER DAY				
**407D	0-555 v	0-300 ma	0.005%	0.01%	0.01%	0.05%	0.5%	500 uv	2 mv	335.00

CONSTANT CURRENT POWER SUPPLY

Featuring 0.1 microamp resolution coupled with high calibration accuracy and excellent long term stability, Model 351A is particularly useful for calibration and testing of instruments, microammeters and milliammeters, etc.



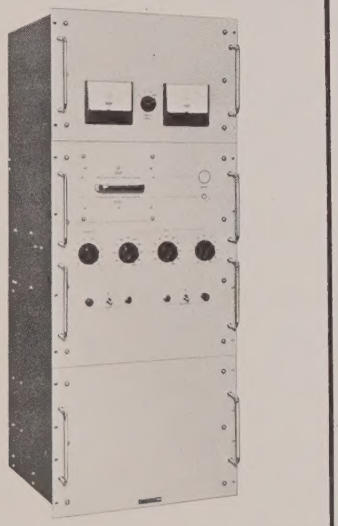
MODEL 351A

MODEL	VOLTAGE	CURRENT	REGULATION		STABILITY		CALI-BRATION ACCURACY	MAX. RIPPLE RMS	RESOLUTION	PRICE
			LINE	LOAD	PER HOUR	PER DAY				
351A	0-100 v	1 ua-100 ma	0.01%	0.01%	0.005%	0.01%	0.05%	0.05%	0.1 ua	$845.00

HIGH VOLTAGE POWER SUPPLIES

Fluke precision High Voltage supplies offer complete coverage up to 30 kv. Inherent characteristics of high calibration accuracy, tight line-load regulation, fine voltage resolution, excellent long term stability, low temperature coefficient plus freedom from corona, jitter, bounce or overshoot have all contributed to a high degree of customer acceptance and satisfaction.

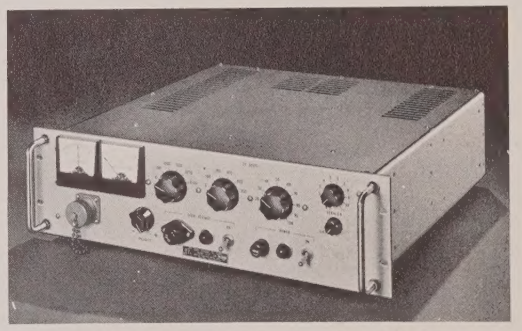
	MODEL	VOLTAGE	CURRENT	REGULATION		STABILITY		CALI-BRATION ACCURACY	MAX. RIPPLE RMS	RESOLUTION	PRICE
				LINE	LOAD	PER HOUR	PER DAY				
TYPICAL APPLICATIONS: Power photomultiplier tubes and ionization chambers . . . for research and development . . . component evaluation and test . . . system calibration.	409A	170-1530 v	0-3 ma	0.01%	1.2%	0.005%	0.02%	—	0.002%	85 v steps	$ 390.00
	412A	500-2010 v	0-15 ma	0.01%	0.03%	0.005%	0.05%	0.25%	5 mv	10 mv	455.00
	413C	0-3111 v	0-20 ma	0.001%	0.001%	0.005%	0.03%	0.25%	150 uv	2 mv	695.00
	405	600-3100 v	0-15 ma	0.01%	0.015%	0.005%	0.05%	0.5%	5 mv	10 mv	595.00
	408A	500-6010 v	0-20 ma	0.01%	0.01%	0.005%	0.05%	0.25%	5 mv	10 mv	695.00
	410A	1000-10,010 v	0-10 ma	0.01%	0.01%	0.005%	0.05%	0.25%	5 mv	10 mv	1,095.00
	430A	10,000-30,220 v	0-10 ma	0.005%	0.01%	0.005%	0.03%	0.25%	5 mv	100 mv	3,900.00



MODEL 430A

Designed specifically to satisfy the most exacting requirements. Important electrical specifications of this supply are generally 10 : 1 better than any 0-3kv supply available in today's market.

MODEL 413C



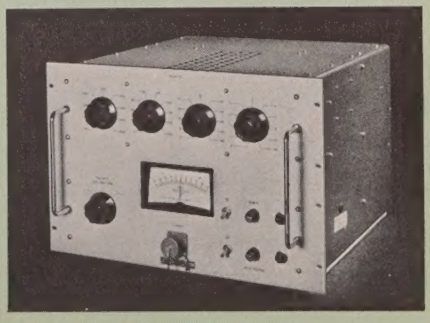
For the first time Model 430A extends the precise electrical specifications of the lower voltage Fluke power supplies to the 30 kv region for such specific applications as powering precision high resolution X-ray equipment, cathode ray tube acceleration and focusing in mass spectrometry applications.

MODEL 409A

MODEL 412A

MODEL 405

MODEL 408A

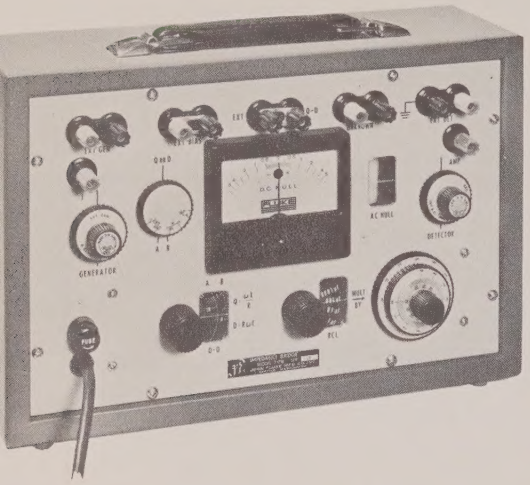


MODEL 410A

Before you specify, call the Fluke sales engineer nearest you for complete information, or a demonstration of any of the above power supplies. You will find a listing of Fluke sales offices on the back cover of this catalog.

UNIVERSAL IMPEDANCE BRIDGE

MODEL 710B



FEATURES

- Measures R, C, L, D, and Q
- Direct In-Line Readout
- Rugged Shaped-Pole Galvanometer (DC Detector)
- Sensitive Electron-Ray Indicator (AC Detector)
- Designed for Simple, Rapid Operation
- Quick-Change Frequency Networks
- Available for Rack Mounting

Model 710B is designed to allow simple and rapid selection of any one of five different bridge configurations for measurement of AC and DC resistance, capacitance, inductance, dissipation factor (D), and storage factor (Q). Bridge arm resistors and capacitance standard are Fluke-manufactured for high accuracy and low temperature coefficient.

SPECIFICATIONS

RESISTANCE:
0.1 milliohm to 12 megohms in 8 ranges

ACCURACY:
± (0.1%+1 dial division)

CAPACITANCE:
0.1 picofarad to 1200 microfarads in 7 ranges

ACCURACY:
± (0.2%+1 dial division)

INDUCTANCE:
0.1 microhenry to 1200 henrys in 7 ranges

ACCURACY:
± (0.3%+1 dial division)

DISSIPATION FACTOR (D):
0.001 to 1.000 at 1 kilocycle

ACCURACY:
$\pm (2\% + 0.005 \times f_{kc})$

STORAGE FACTOR (Q):
0.1 to 1000 at 1 kilocycle

ACCURACY:
$\pm (2\% + 0.005 \times f_{kc})$

FREQUENCY RANGE:
DC to 20 KC (1 KC Quick-Change networks supplied as standard equipment)

INPUT POWER:
115/230V AC ± 10%, 50-800 cps, 12 watts

DIMENSIONS:
Cabinet Model—13″ long x 9½″ wide x 6″ high
Rack Model—7″ high x 19″ wide x 4″ behind panel

WEIGHT:
Cabinet Model—11¾ pounds
Rack Model—10 pounds

PRICE:
Cabinet Model—$485.00
Rack Model—$505.00

OPTIONAL ACCESSORIES:
Quick-Change RC generator and detector networks for the following frequencies; 100 cps, 120 cps, 400 cps, 500 cps, 800 cps, 2 KC, 5 KC, 10 KC, and 20 KC. Price $20.00 per set.

John Fluke Mfg. Co., Inc.

P.O. Box 7428, Seattle 33, Wash.

PR 6-1171 TWX—206-879-1864 TLX—852

FLUKE SALES REPRESENTATIVES IN THE UNITED STATES AND CANADA

Albany, New York
J. A. Reagan Co., Inc.
419 Central Avenue
Albany, New York
436-9649

Albuquerque, New Mexico
Barnhill Associates
319A Wyoming Blvd., N.E.
Albuquerque, New Mexico
265-7766

Baltimore, Maryland
Electronic Marketing Associates
125 Aylesbury Road
Timonium, Maryland
825-0300

Boston, Massachusetts
Technical Instruments, Inc.
122 West Street
Wilmington, Massachusetts
REading 944-3930

Bridgeport, Connecticut
Technical Instruments, Inc.
575 Broad Street
Bridgeport, Connecticut
FOrest 8-4582

Buffalo, New York
J. A. Reagan Co., Inc.
327 Westmoreland Road
Buffalo, New York
839-3998

Chicago, Illinois
Cozzens & Cudahy, Inc.
125 Old Orchard Arcade
Skokie, Illinois
ORchard 5-6700

Cleveland, Ohio
M. P. Odell Company
26614 Center Ridge Road
Westlake, Ohio
TRinity 1-8000

Dallas, Texas
Dannemiller-Smith, Inc.
2712 W. Mockingbird Lane
Dallas, Texas
FLeetwood 7-8249

Dayton, Ohio
M. P. Odell Company
1250 W. Dorothy Lane
Dayton, Ohio
298-9964

Denver, Colorado
Barnhill Associates
1170 S. Sheridan Blvd.
Denver, Colorado
934-5505

Detroit, Michigan
M. P. Odell Company
14027 Puritan Ave.
Detroit, Michigan
838-7324

Greensboro, North Carolina
BCS Associates, Inc.
1020 E. Wendover Avenue
Greensboro, North Carolina
273-1918

Honolulu, Hawaii
Industrial Electronic, Inc.
646 Queen Street
Honolulu, Hawaii
506-095

Houston, Texas
Dannemiller-Smith, Inc.
2120 S. Post Oak Road
Houston, Texas
SUnset 2-7350

Huntsville, Alabama
BCS Associates
2317 Bob Wallace Ave. S.W.
Huntsville, Alabama
534-1648

Kansas City, Kansas
Impala, Inc.
7540 Lowell
Overland Park, Kansas
NI 8-6901

Los Angeles, California
McCarthy Associates, Inc.
511 Mission Street
South Pasadena, California
682-3981
799-9593

Milwaukee, Wisconsin
Cozzens & Cudahy, Inc.
4430 North Wilson Drive
Milwaukee, Wisconsin
EDgewood 2-0700

Minneapolis, Minnesota
Cozzens & Cudahy, Inc.
9725 Girard Ave. So.
Minneapolis, Minnesota
881-2121

New Hartford, New York
J. A. Reagan Co., Inc.
10 Humphreys Terrace
New Hartford, New York
732-3775

New York, New York
G. Curtis Engel & Associates, In
New York, New York
REctor 2-0001

Orlando, Florida
BCS Associates, Inc.
601 N. Fern Creek Avenue
Orlando, Florida
241-1091

Philadelphia, Pennsylvania
G. Curtis Engel & Associates, In
Philadelphia, Pennsylvania
WAlnut 2-3270

Phoenix, Arizona
Barnhill Associates
30 Pima Plaza
Scottsdale, Arizona
956-0091

Pittsburgh, Pennsylvania
M. P. Odell Company
Oakmont, Pennsylvania
FRemont 1-1231

Ridgewood, New Jersey
G. Curtis Engel & Associates, In
210 South Broad Street
Ridgewood, New Jersey
GIlbert 4-1400

Salt Lake City, Utah
Barnhill Associates
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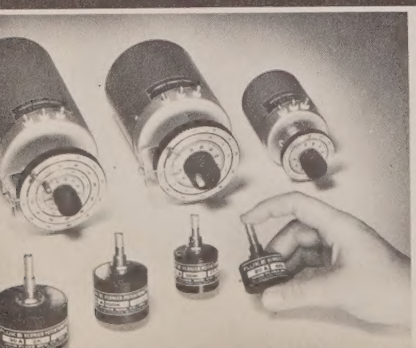
PRECISION VERNIER AND DECADE POTENTIOMETERS AND RHEOSTATS



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